

# Review of the Institute of Medicine Report: Long-term Health Consequences of Exposure to Burn Pits in Iraq and Afghanistan

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## BACKGROUND

A previous issue of the *AMEDD Journal* included an article<sup>1</sup> I wrote concerning solid waste disposal in the US Central Command (CENTCOM) area of operations. That article described how the Department of Defense (DoD) conducted numerous monitoring studies at Joint Base Balad (JBB), the location with the US military's largest burn pit in theater. Screening health risk assessments, publicly released in 2008,<sup>2</sup> stated that the burn pits at JBB and other US military locations in Iraq posed an "acceptable health risk" based on the contaminant levels measured. While sampling can be used to identify a potential concern, it does not refute every concern because it cannot address all locations and conditions at all times. I discussed the limitations of the sampling efforts, including the points that sampling identifies conditions at the time of sampling, and that burn pit sampling was intermittent while waste streams and meteorological conditions were variable. As waste streams vary, analyte concentrations would be expected to vary. The methodology does not incorporate particulate matter (PM) such as PM<sub>10</sub> or PM<sub>2.5</sub> concentrations. Particulate matter is a mixture, and does not have a toxicological value for use in the methodology. The list of analytes was not exhaustive. Screening health risk assessments indicate the general probability that a risk is present under very specific exposure conditions. This can be useful to make decisions regarding the need to take remedial actions, but is not well-suited to inform regarding an individual's health risk.

To further evaluate the potential health impact of burning trash, the Armed Forces Health Surveillance Center conducted a retrospective cohort study<sup>3</sup> to compare the incidence rates among deployers and nondeployers for respiratory diseases, circulatory diseases, cardiovascular disease, ill-defined conditions, and sleep apnea; compare the responses on the postdeployment health assessment forms among individuals deployed to one of several CENTCOM locations with and without burn pits; and compare the rates and proportions of medical encounters for respiratory outcomes while assigned to various CENTCOM locations. To address the issue of

particulate matter exposure, service members in Korea (where particulate matter levels are high) were also included, as well as a nondeployed control population. The main finding was that for nearly all health outcomes measured, service members from the CENTCOM locations and Korea had either similar or significantly lower incidence rates compared to the US-based cohort. The exception was that personnel assigned to a deployed site without a burn pit had a measurably higher rate of signs, symptoms, and ill-defined conditions noted postdeployment. For health outcomes measured during the deployment period, Air Force personnel at Joint Base Balad had a higher proportion of respiratory encounters, yet this was not noted among Army members at the same location, or for military personnel at the other burn pit sites which were studied. The report concluded that, while the study had limitations, the results taken collectively generally showed no impact of burn pit exposure several years postdeployment. They recommended further improvement in the quality of individual-level exposure data, to include data from additional burn pit sites, and further investigation of possible long-term health effects. Strengths of the study included the ability to use comprehensive electronic medical records and the large size of the population for statistical analysis. As with many epidemiological studies, limitations are also recognized, for example, measures of individual exposures, some exposure misclassification, lack of information on job duties, and information on smoking behavior.

Personnel are exposed to dust and ambient particulate matter while deployed, often in conjunction with other exposures such as burn pit smoke and local industrial emissions. Sampling data indicates variable conditions to include occasions where levels exceed certain health guidelines.<sup>4</sup> High levels of ambient particulate matter and burn pit smoke can irritate the eyes and respiratory passages at the time of exposure. Air pollution literature indicates that such exposures could cause or exacerbate chronic lung conditions, including chronic bronchitis and asthma, with effects dependant on the degree and duration of exposure, as well as characteristics of the population being exposed.<sup>5,6</sup> The completed scientific

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14. ABSTRACT <b>A previous issue of the AMEDD Journal included an article1 I wrote concerning solid waste disposal in the US Central Command (CENTCOM) area of operations. That article described how the Department of Defense (DoD) conducted numerous monitoring studies at Joint Base Balad (JBB), the location with the US military?s largest burn pit in theater. Screening health risk assessments, publicly released in 2008,2 stated that the burn pits at JBB and other US military locations in Iraq posed an ?acceptable health risk? based on the contaminant levels measured. While sampling can be used to identify a potential concern, it does not refute every concern because it cannot address all locations and conditions at all times. I discussed the limitations of the sampling efforts, including the points that sampling identifi es conditions at the time of sampling, and that burn pit sampling was intermittent while waste streams and meteorological conditions were variable. As waste streams vary, analyte concentrations would be expected to vary. The methodology does not incorporate particulate matter (PM) such as PM10 or PM2.5 concentrations. Particulate matter is a mixture, and does not have a toxicological value for use in the methodology. The list of analytes was not exhaustive. Screening health risk assessments indicate the general probability that a risk is present under very specifi c exposure conditions. This can be useful to make decisions regarding the need to take remedial actions, but is not well-suited to inform regarding an individual?s health risk.</b>					
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studies evaluating the association between environmental exposures encountered during deployment to Iraq and/or Afghanistan and lung health indicate a range of different findings. These include no evidence of an association between deployment-related exposures and chronic respiratory conditions,<sup>3</sup> an association between specific lung diseases and deployment,<sup>7</sup> and evidence of increased respiratory symptoms but not a specific diagnosed disease.<sup>8</sup> Additional conditions such as acute eosinophilic pneumonia and constrictive bronchiolitis are described in case series from which epidemiologic associations cannot be directly estimated.<sup>9,10</sup> Although all of these studies have methodological limitations that constrain the strength of the conclusions being drawn, their findings warrant continued investigation.

Given the lack of clear consensus and in response to concerns expressed by military personnel, Veterans, their families, and Congress, the Department of Veterans Affairs (VA) asked the Institute of Medicine (IOM)\* to:

Determine the long-term health effects from exposure to burn pits in Iraq and Afghanistan. Specifically, the committee will use the Balad Burn Pit in Iraq as an example and examine existing literature that has detailed the types of substances burned in the pits and their by-products.<sup>11(p1)</sup>

### APPROACH USED BY THE IOM COMMITTEE

The committee used 3 sources of information in their deliberations. The first was the actual monitoring data from JBB. The report noted that while the Balad assessments were useful, information regarding the waste streams at particular locations was not available apart from general information on percentages of plastics, wood, metal, and other combustible and noncombustible items burned. They also acknowledged that the sampling did not include criteria pollutants such as ozone, carbon monoxide, and sulfur dioxide, although this was due to difficulties in conducting this sampling in a deployed setting. They concluded that background ambient air concentrations of PM were high, with average concentrations above US air pollution standards, and were most likely derived from local sources. Dioxin compounds were detected at low concentrations, although high even when compared to polluted urban areas, and the burn pit was the likely source. Volatile organic compounds and polycyclic aromatic hydrocarbons were similar to those reported for polluted urban environments outside the United States. The report concluded that personnel were

exposed to a mixture of combustion products from the burn pit and other air pollutants from local and regional sources, including other combustion sources, ground transportation, stationary power generation, the Balad airport, other industry, and wind-blown soil.

The second phase of their approach involved a review of the monitoring data from JBB and evaluation of the potential health effects of compounds detected in more than 5% of samples, or expected to be present. There were 51 such compounds which were evaluated for potential cancer and noncancer health effects. These chemicals were categorized as dioxins and furans, volatile organic compounds, and particulate matter. The “potential health effects” associated with exposure to these chemicals at sufficient levels were stated as:

- ▶ Neurological effects and reduced central nervous system functions
- ▶ Liver toxicity and reduced liver function
- ▶ Cancer (stomach, respiratory, skin, leukemia, others)
- ▶ Respiratory toxicity and morbidity
- ▶ Kidney toxicity and reduced kidney function
- ▶ Blood effects (anemia, etc)
- ▶ Cardiovascular toxicity and morbidity
- ▶ Reproductive and developmental toxicity

The committee acknowledged that potential health effects associated with any single compound have “little predictive value” for deployed personnel at JBB. This determination was reached because although most of the detected pollutants were present at concentrations lower than the health-based reference values, sampling was limited in time. Individual exposure levels would be expected to vary. For example, exposure would be higher for those who worked at or near the burn pit (which in fact was quite large) than for those located elsewhere on the Balad camp. Additionally, concentration of PM exceeded US standards, but PM composition and characteristics can vary with the source and contributors. Literature on the health effects of exposure to mixtures, and specifically mixtures from burn pits is minimal.

These issues led the committee to the third aspect of their assessment; a review of the epidemiologic literature on health outcomes associated with exposure to burn pit emissions (military studies) and other populations with exposure to similar combustion sources (firefighters, workers at municipal incinerators, residents who live near incinerators, and Veterans of the 1990-1991 Persian Gulf War who were exposed to smoke from oil-well

\*The Institute of Medicine is the health component of the National Academy of Sciences. It is an independent, nonprofit organization that works outside of government to provide unbiased and authoritative advice to decision makers and the public. Information: <http://www.iom.edu/About-IOM.aspx>.

fires) to identify health outcomes potentially related to combustion products similar to burn pit emissions. All studies are known to have limitations and uncertainties, including the “healthy worker” effect, exposure misclassification, lack of information on confounders, inadequate statistical power, disease misclassification and publication bias. Considering these and the information from the studies reviewed, the committee then adopted the categories of association used for previous reports regarding the first Gulf War and health, and Agent Orange and health, based on the weight of evidence. The 5 categories were sufficient evidence of a causal relationship, sufficient evidence of an association, and limited, suggestive, or inadequate evidence based on available data.

#### FINDINGS OF THE COMMITTEE

As noted, the report concluded that the mixture of chemicals from regional background and local sources that contribute to the high PM may be of the greatest concern at JBB. As previously described, the PM consists of windblown dusts and elemental carbon and metals that arise from transportation and local industrial activities.<sup>12</sup> The committee considers the air pollution literature related to particulate matter to be relevant to military personnel deployed to the Middle East. Weese and Abraham<sup>4</sup> noted that the potential health implications of the PM measured in an extensive sampling event in deployed locations in the Middle East included respiratory and cardiovascular outcomes.

Overall, the committee concluded:

In light of its assessment of health effects that may result from exposure to air pollutants detected at JBB and its review of the literature on long-term health effects in surrogate populations, the committee is unable to say whether long-term health effects are likely to result from exposure to emissions from the burn pit at JBB. However, the committee’s review of the literature and the data from JBB suggests that service in Iraq and Afghanistan—that is, a broader consideration of air pollution that exposure only to burn pit emissions—might be associated with long-term health effects, particularly in highly exposed populations (such as those worked at the burn pit, or susceptible populations (for example, those who have asthma) mainly because of the high ambient concentrations of PM from both natural and anthropogenic, including military, sources. If that broader exposure to air pollution turns out to be sufficiently high, potentially related health effects of concern are respiratory and cardiovascular effects and cancer.<sup>11(p7)</sup>

The committee determined that there is inadequate/insufficient evidence of an association between exposure to combustion products and cancer, respiratory disease, circulatory disease, neurologic disease, and

adverse reproductive and developmental outcomes in the population studied. The report concluded that there was limited/suggestive evidence of an association between exposure to combustion products and reduced pulmonary function in the populations studied. It was acknowledged that the results in the populations studied (firefighters and people living near incinerators) may not be generally applicable to military personnel exposed to emissions from burn pits.

So what does this really mean? The report noted that no individual chemical constituent of the combustion products emitted at JBB was measured at levels likely to be responsible for adverse health effects discussed. However, the sampling had limitations and the issue of mixed and cumulative exposures remains. These include not only PM and combustion products, but other interacting factors such as stress, smoking, and local climatic conditions. The report identifies the value of better exposure characterization. Individual monitoring data would greatly reduce misclassification bias and potentially allow for an assessment of dose/response, but the burn pit in Balad has closed and the drawdown in troops in the CENTCOM area makes extensive monitoring unlikely. Also recommended was a prospective study on individuals who were deployed to Balad, with an attempt to classify the exposure into low, medium, and high. Identifying highly exposed subgroups within those deployed to Balad is not possible from deployment location records, but comparison of groups deployed there during the height of burn pit use as opposed to after initiation of incinerator use is another approach. Additionally, it recommended extending the study for a longer time period to address conditions which would not arise immediately due to latency. This is being accomplished. The Armed Forces Health Surveillance Center is repeating the prior study with a longer period of follow-up. This study design was very similar to the design recommended by the Institute of Medicine, including outcomes associated with proximity to exposure and outcome comparisons between deployed personnel who were exposed to burn pits and deployed personnel without such exposure. An independent oversight committee comprised of military and external experts was also recommended, and is being explored.

It was noted that pilot studies should be conducted to address the issues of statistical power and to develop design features for specific health outcomes. At present, studies are being conducted among a predeployment population at Fort Hood, Texas, and in a new recruit population at Fort Sam Houston, Texas, to assess the feasibility of conducting baseline spirometry at predeployment and at accession into the military. The use of



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screening spirometry in an asymptomatic population is not currently recommended.<sup>13,14</sup> However, the rationale for baseline testing is that military members, as a group, might have better lung function than the reference populations used for comparison. Traditional evaluation of pulmonary function determines whether test results are in the normal range, which is based on asymptomatic nonsmokers. If individuals have above average lung function at baseline, it is possible over time to drop, unnoticed, from the top to the bottom of the normal range without dropping below the normal range. In this case, changes from a baseline would be more meaningful and might detect impacts to pulmonary function earlier.<sup>15</sup>

It is also important to obtain smoking status for use in epidemiological studies, and to move towards a smoke-free Army. A prospective evaluation performed by the Millennium Cohort Study team\* found greater percentages of smoking initiation in never-smokers, smoking resumption in past smokers, and increased smoking in current smokers among service members with a history of deployment when compared to nondeployers.<sup>17</sup> Smoking is typically raised as an issue when discussing respiratory health outcomes, but not merely to attribute health effects to another cause. The inflammation associated particularly with new-onset smoking might make one more susceptible to exposures. For example, acute eosinophilic pneumonia, a serious but uncommon respiratory condition diagnosed in some deployed individuals, appears to be related to new-onset smoking.<sup>9</sup>

The DoD and VA have recognized the need to address burn pit exposure as well as other exposure effects on pulmonary function and disease. Additionally, organ systems other than the pulmonary system are affected by at least some of the chemicals involved with burn pit smoke and other airborne exposures. The DoD and VA now consider deployment-related airborne hazards a better focus than burn pits. The first study by the Armed Forces Health Surveillance Center used locations in the CENTCOM area of operations (specifically, 2 burn pit sites and 2 nonburn pit sites). The selected locations allowed comparisons between sites where individuals were exposed to burn pit smoke and sites where individuals were not exposed to burn pit smoke, but were exposed to other pollution sources, such as particulate matter and pollution from local industry. The studies evaluated circulatory diseases, cardiovascular disease,

signs, symptoms, and ill-defined conditions, as well as respiratory diseases. The Naval Health Research Center component of the study evaluated birth outcomes in infants whose mothers and fathers had been exposed before and during pregnancy, chronic multisystem illness, lupus, and rheumatoid arthritis. Continued follow-up of these cohorts will provide information regarding deployment related exposures in addition to burn pits and any health condition can be included in the analysis.

A number of Veterans groups have worked for recently introduced federal legislation that mandates a VA burn pit registry.<sup>18</sup> According to Congressman Todd Akin, who authored the legislation:

Unfortunately the VA has struggled to help these Veterans. Creating a burn pit registry is an important step to help these Veterans get the care and support they need and that our nation has promised them.<sup>18</sup>

However, given that the IOM concluded that ambient air pollution may pose greater health risks than chemicals emitted from military burn pits, mandating a registry of those exposed to burn pits might not target individuals at risk of health outcomes. Registries enable medical follow-up and outreach efforts. A registry and subsequent studies limited to those who self-report exposure to burn pits may miss identifying adverse health effects in those exposed to wider pollution. According to the IOM report, there are no illnesses specifically associated with burn pit exposure and, therefore, no markers to allow for medical follow-up. However, the broader question of deployment-related inhalational exposures and health outcomes deserves continued study.

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\*The Millennium Cohort Study is an ongoing, longitudinal cohort study designed to evaluate any long-term health effects of military service, including deployments. Based at the Naval Health Research Center in San Diego, CA, it is the largest prospective study ever undertaken in the US military.<sup>16</sup>

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